Agenda Item 4.4

Priorities in the Implementation of the Triennium Work Plan (2010-2012)
Review of New Information on the Extent of Negative Effects of Sound

Document 4-08

Final Report of the ASCOBANS Intersessional Working Group on the Assessment of Acoustic Disturbance

Action Requested

- Take note of the report and recommendations
- Comment

Submitted by

Working Group

NOTE:
IN THE INTERESTS OF ECONOMY, DELEGATES ARE KINDLY REMINDED TO BRING THEIR OWN COPIES OF DOCUMENTS TO THE MEETING

Final Report of the ASCOBANS Intersessional Working Group on the Assessment of Acoustic Disturbance

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Convener's note: Thanks to the contributors listed above and to the others who have contributed directly or indirectly to this report. This document is the final report of the Intersessional Working Group to the ASCOBANS Advisory Committee. With the submission of this report, the working group considers its work under the Terms of Reference agreed at AC15 completed. It contains a series of recommendations to ASCOBANS Parties and others who may be considering the management and mitigation of noise generating activities in the ASCOBANS region. As understanding of underwater sound is developing rapidly, so such advice will also need to evolve.

1. Introduction

In the marine environment hearing is a primary sense for many organisms. Many species of fish and marine mammals depend heavily on sound to navigate, to communicate, to avoid predators and to find food. Cetaceans are known to be especially susceptible to acoustic disturbance expressed as stress, habitat displacement, behavioural changes, physical injury or even death[1]. As we continue to industrialise the oceans, underwater noise generated by anthropogenic activities has increased dramatically in recent decades. In the ASCOBANS area, as in most other regions, a combination of noise sources has made the oceans noisier than they have ever been before and sources include commercial shipping, oil and gas exploration and production, oceanographic research, military sonar activities, dredging, underwater detonations and other industrial activities. Furthermore it has been acknowledged that effects in combination may interact synergistically to have a greater impact (i.e. cumulative effects) creating an additional threat[2].

As our understanding of noise pollution increases, so our awareness of the likely consequences of combined stressors will improve and therefore advice such as this document should be regularly updated to reflect this.

Here we seek to provide independent advice to ASCOBANS's parties and others in the region concerning the potential mitigation measures that should be deployed to minimise noise impacts on marine wildlife, with a particular focus on small cetaceans.

2. ASCOBANS and Marine Noise

Since its inception, ASCOBANS has exercised a clear remit to address the acoustic disturbance of small cetaceans. The Agreement text specifically identifies "disturbance" as a factor that may adversely affect small cetaceans within the Agreement area. The Conservation and Management Plan requires the Parties to work towards the prevention of significant disturbance, "especially of an acoustic nature". Furthermore, the ASCOBANS Conservation and Management Plan requires research to identify present and potential threats to small cetaceans. This would clearly include threats of an acoustic nature.

It has been the clear intention of the ASCOBANS Parties that the disturbance of small cetaceans be addressed expeditiously. At the First Meeting of the Parties (MOP) in 1994, the Parties were "encouraged to introduce guidelines to reduce disturbance" (Resolution on the Implementation of the Conservation and Management Plan). This mandate was subsequently reinforced at the Second MOP in 1997, where the parties were requested to "introduce, where appropriate, guidelines and other measures to reduce disturbance to small cetaceans", with particular concerns raised over seismic surveys (Resolution on the Further Implementation of ASCOBANS).

At the Third MOP in 2000, the first specific Resolution on Disturbance was adopted (Resolution No. 4: Disturbance) in which the Parties recognised that "the difficulty of proving the detrimental effects of acoustic disturbance on cetaceans necessitates a precautionary approach in dealing with this issue", and further reiterated the need to develop guidelines to reduce disturbance to small cetaceans. Resolution No. 4 also mandated the development of guidelines and procedures to mitigate impacts of seismic surveys, to work with military

[1] A variety of literature supports this general point e.g. Southall, Bowles, Ellison, Finneran, Gentry, Green Jr, Kastak, Ketten, James Miller, Nachtigall, Richardson, Thomas, Tyack. (2007) Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Special Issue of the journal Aquatic Mammals Volume 33, Number 4, pp 411-522: Mark Simmonds, Sarah Dolman and Lindy Weilgart (2004) *Oceans of Noise A WDCS Science Report* 168 Pages published by WDCS and available on their website; and Weilgart, L.S. 2007. The impacts of anthropogenic noise on cetaceans and implications for management. Can. J. Sool. 85 (11): 1091-1116.

[2] Crain C.M., Kroeker, K. and..Halpern, B.S. (2008) Interactive and cumulative effects of multiple human stressors in marine systems. Ecology Letters 11

authorities to introduce codes of conduct and to support further research on the impacts of shipping and acoustic by-catch mitigation devices on small cetaceans.

Resolution No. 4 of the Third MOP was subsequently repealed at the Fourth MOP in 2003, and replaced with Resolution No. 5*:* Effect of Noise and of Vessels. This Resolution again called for the development of appropriate management measures and guidelines to minimise the adverse impacts on small cetaceans of sound from vessels, acoustic harassment devices, offshore extractive and industrial activities and other acoustic disturbances, and to develop with military authorities effective mitigation measures to address the impact of military activities.

Resolution No. 5 was subsequently repealed at the Fifth MOP in 2006 and replaced with Resolution No. 4: Adverse Effects of Sound, Vessels and Other Forms of Disturbance on Small Cetaceans. This Resolution, which provides the current mandate for activity in relation to disturbance under the auspices of ASCOBANS, reiterates the request to conduct further research into these issues and to develop appropriate management measures, guidelines and technological adaptations to minimise any adverse effects on cetaceans of acoustic disturbances.

In addition to the acoustic-related Resolutions of the MOPs, relevant discussions have been held annually within the ASCOBANS Advisory Committee (AC) Meetings. At the First Meeting of the AC, convened in 1995, four broad categories of disturbance to small cetaceans were identified: seismic testing and shipping noise, sonar disturbances from military sources and whale-watching activities. These issues have been regularly discussed within the AC, culminating in the establishment of an Intersessional Working Group on the Assessment of Acoustic Disturbance at the Fifteenth Meeting of the AC in 2008.

The need for guidance regarding the effective mitigation of acoustic disturbance to small cetaceans in the ASCOBANS Agreement area has therefore been consistently called for. In addition, ASCOBANS Parties are committed under both international law and European Union legislation to address noise sources in the marine environment, within the waters covered under the terms of the ASCOBANS Agreement.

To this end, the Intersessional Working Group on the Assessment of Acoustic Disturbance was tasked with examining and evaluating human activities causing noise disturbance and related best practices in noise management in relation to the work of ASCOBANS.

Terms of Reference as agreed at ASCOBANS AC 15 (2008):

It was agreed that the Intersessional Working Group on the Assessment of Acoustic Disturbance should focus on three main human activities:

- use of active naval sonar (including from warships, sonobuoys and helicopters)
- seismic surveys (including for oil and gas exploration and scientific research)
- pile-driving (associated with coastal developments and marine renewable energy)

and also give consideration to ship-based noise, as far as is appropriate, recognising that this issue is under consideration at the International Maritime Organisation (IMO).

For each of these activities, the working group will:

1. Examine the existing management (including impact mitigation) of the activities with regard to noise;
2. Summarise the assessments that have been made, and indicate the main concerns relevant to the ASCOBANS objectives; and,
3. Identify or prepare guidance and recommendations for best practice.

The working group will preferably work through email correspondence. Drafts of the assessments and guidance and recommendations for best practice will be presented to the members of the ASCOBANS AC before the next meeting of the AC.

The working group identified the ACCOBAMS *"Guidelines to address the issue of the impact of anthropogenic noise on marine mammals in the ACCOBAMS area"* as being a good and comprehensive baseline for development of relevant ASCOBANS guidance. Accordingly, the working group adopted and modified these guidelines with respect to circumstances, current scientific literature and the legal framework in the ASCOBANS area.

A preliminary draft of this report was provided to the sixteenth meeting of the ASCOBANS Advisory Commitee in April 2009. At that meeting the working group was also asked to consider noise arising from marine renewable energy sources in operation.

3. The relevant legal framework

As our understanding has increased in recent years, so the negative impacts of anthropogenic noise on cetaceans have received consideration in a variety of international and regional organisations. In addition, national regulations and guidelines have been developed by some Parties to ASCOBANS. To this end, a distinct legal framework to address noise sources is clearly emerging. This framework comprises binding and legally-enforceable provisions, as well as influential "soft" law provisions in the form of Resolutions and Recommendations of international bodies and organisations.

The primary binding and legally enforceable obligations incumbent on Parties to ASCOBANS – as well as potential future Parties to the Agreement under the expansion of the ASCOBANS Area – are those established by the European Union. Of additional influence to the ASCOBANS Parties are the 'softer' instruments advanced by key international organisations, especially by the parent convention, the Convention in the Conservation of Migratory Species of Wild Animals 1979 (CMS) and by the International Convention for the Regulation of Whaling 1946 (ICRW). In addition to this, initiatives such as those pursued through the International Maritime Organisation and Regional Seas Conventions, may also be of practical relevance within the ASCOBANS Area.

3.1 European Union

As far as the EU provisions are concerned, anthropogenic noise sources are to some extent addressed under two key Directives, namely Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the "Habitats and Species Directive") and Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (the "Marine Strategy Framework Directive", or "MSFD").

3.1.1 The Habitats Directive

The Habitats Directive adopts a two-pronged approach to nature conservation. Firstly, and exclusively for species listed in Annex II of the Directive, the Member States must establish Special Areas of Conservation (SACs), known collectively as the Natura 2000 network. There are two species of small cetaceans listed in Annex II at present: the harbour porpoise and the bottlenose dolphin. Secondly, Member States must establish a system of "strict protection" for animal species in their natural range that are listed in Annex IV(a) of the Directive, including all species of cetaceans. Accordingly, it may be considered that protection from the adverse impacts of anthropogenic noise would constitute a significant component of the "strict protection" of small cetaceans.

In relation to SACs, in May 2007 the European Commission advanced a series of indicative (yet non-binding) Guidelines for the Establishment of the Natura 2000 Network in the Marine Environment. The Guidelines explicitly noted oil and gas exploration and whale- and dolphin-watching activities as examples of typical sources of disturbance in the cetacean environment. Moreover, Article 6(2) of the Habitats Directive requires Member States to "take

appropriate steps" to avoid the disturbance of Annex II species within SACs. It is, however, somewhat unclear as to the precise point at which this obligation becomes operational, since it applies only "in so far as such disturbance could be significant in relation to the objectives of this Directive", i.e. to maintain harbour porpoises and bottlenose dolphins at a "favourable conservation status". There is also scope for the Member State authorities to permit noise-producing activities within SACs for small cetaceans where there are "imperative reasons of overriding public interest, including those of a social or economic nature" (Article 6(4) of the Directive).

As far as "strict protection" of all European species of small cetaceans is concerned, Article 12(1) of the Habitats Directive prohibits their deliberate disturbance, particularly during periods of breeding, rearing, hibernation or migration.

3.1.2 The Marine Strategy Framework Directive

The MSFD, which was formally adopted in June 2008, seeks to facilitate "a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status within the marine environment by the year 2020 at the latest" (Article 1(1) of the Directive). This objective entails the provision of "ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions" for which the impact of substances and energy – specifically including noise – does not cause pollution effects (Article 3(5) of the Directive).

To this end, the concept of "pollution" as recognised by the MSFD specifically includes "human-induced marine underwater noise" (Article 3(8) of the Directive). Moreover, the qualitative descriptors for demonstrating a "good environmental status" specifically address underwater noise (Annex I), while the indicative list of pressures upon the marine environment list "shipping, underwater acoustic equipment" as particular – although non-exhaustive – examples (Annex III). In the course of 2009, the Commission, assisted by the Joint Research Centre (JRC) and ICES, will develop criteria and methodological standards in relation to eight of the eleven GES descriptors in the MSFD, including underwater noise, in order to get from very general definitions of the descriptors to a common understanding of what GES is, and how status of ecosystems relative to it should be quantified. Stakeholders, including ASCOBANS and Member States are also involved in this process.

The MSFD seeks to facilitate regulatory activity in respect of the marine environment on both a national and regional level and to make use of existing regional structures to address marine environmental concerns (Article 6(1) of the Directive). Accordingly, a degree of opportunity exists for ASCOBANS to contribute to the emerging policy framework within the EU to address underwater noise. Transposition of the MSFD must be undertaken by member states by July 2010.

3.2 International Agreements

3.2.3 Convention on Migratory Species

The negative effects of ocean noise were first identified at the Seventh COP of the Convention on Migratory Species (CMS) in Resolution 7.5: Wind Turbines and Migratory Species. The Parties expressed concerns over the possible impact of offshore wind developments on migratory species of mammals and birds, including *inter alia* the "emission of noise and vibrations into the water".

More specifically, at the Eighth COP a series of indicative threats to species of cetaceans was identified in Resolution 8.22: Adverse Human Induced Impacts on Cetaceans. Resolution 8.22 noted explicitly "marine noise" as one such issue, and invited the parties to "ensure wherever possible" that they avoided harm to cetaceans.

Most recently, at the Ninth COP in December 2008, substantial consideration was given to the issue of ocean noise and its impact upon cetaceans. Resolution 9.9: Migratory Marine Species identifies "marine noise impacts" as one of the "multiple, cumulative and often synergistic threats" to cetaceans. More importantly, the adoption of Resolution 9.19: Adverse Anthropogenic Marine/Ocean Noise Impacts on Cetaceans and Other Biota, specifically notes the developments within ASCOBANS and ACCOBAMS on ocean noise and disturbance, and urges special care to be taken to control the emission of man-made noise. Resolution 9.19 also calls for the adoption of migration measures for high intensity active naval sonar, to consult with relevant stakeholders on issues of best practice, to undertake further research regarding sources and impacts of ocean noise and, in particular, to "endeavour to develop provisions for the effective management of anthropogenic noise in CMS daughter agreements and other relevant bodies and conventions".

3.2.4 International Convention for the Regulation of Whaling (ICRW)

The ICRW has a strong advisory role to play in the context of ASCOBANS initiatives. Although there has been no universal agreement between the Parties to the ICRW with respect of the competence of the International Whaling Commission (IWC) to address small cetaceans, the IWC, through its Scientific Committee has a long-standing interest both in the conservation of small cetaceans, as well as the impact of anthropogenic ocean noise upon cetaceans. Moreover, the IWC has identified through its Memorandum of Understanding with the CMS the need to "pursue complementary and mutually supportive actions in respect of small cetaceans" (Resolution 2001-13: Resolution on Small Cetaceans).

The IWC has not adopted a resolution exclusively on ocean noise in a manner analogous to the CMS or ASCOBANS. Nevertheless, as early as 1981 it noted "the possible effects on whale stocks which may be caused by shipping and off-shore mining and drilling activities" (Resolution 1981-7: Resolution Relating to Pollutants in Whales). To date, noise-producing activities have instead been addressed primarily through the Standing Working Group on Environmental Concerns. Throughout the 1990s a series of Resolutions called upon the IWC Scientific Committee to conduct research into the impacts of environmental changes upon cetaceans, from which "noise" was expressly identified as an area of further study (Resolution 1994-13: Resolution on Research on the Environment and Whale Stocks) and directed the Standing Working Group on Environmental Concerns to consider *inter alia* "the impact of noise" (Resolution 1996-8: Resolution on Environmental Change and Cetaceans). In 1997, the Standing Working Group on Environmental Concerns identified eight topics of particular importance to cetaceans, including the impact of noise (Resolution 1997-7: Resolution on Environmental Change and Cetaceans), for which research work has been on-going. In 2006 the IWC held a Workshop on Seismic Surveys that came up with some useful recommendations.

On a related theme, the IWC has also considered the potential impact of whale-watching. Although such activities were initially considered "a matter for the responsible coastal state rather than for the Commission" (Resolution 1994-14: Resolution on Whalewatching), the IWC has qualified this view slightly, considering that it "has a continuing part to play in monitoring and providing guidance on the sustainable development of whalewatching" (Resolution 1996-2: Resolution on Whalewatching), which would include addressing disturbance during the pursuit of such activities.

3.2.5 United Nations initiatives

i. UN Convention on the Law of the Sea 1982

The UN Convention on the Law of the Sea 1982 (LOSC), described as "a constitution for the oceans", does not expressly cite ocean noise as a pollutant. However, the definition of "pollution of the marine environment" advanced in Article 1(4) of the LOSC – "the introduction by man, directly or indirectly, of substances *or energy* into the marine environment, including

estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities" (emphasis added) – has been widely interpreted by legal scholars as including ocean noise. Accordingly, the general obligations in respect of marine pollution established within Part XII of the Convention to address pollution of the marine environment have been widely considered in recent years as extending to addressing the problems raised by ocean noise.

ii. International Maritime Organization (IMO)

The International Maritime Organization (IMO) is a UN Specialised Agency dealing with shipping issues, maritime safety, efficiency of navigation and the control of marine pollution from ships. Accordingly, the IMO is of particular importance in addressing the issue of ocean shipping noise.

The IMO has yet to develop a specific series of measures governing vessel-source noise. However, as noted by the Resolution 9.19 adopted by the Ninth COP to the CMS, the IMO Marine Environmental Protection Committee (MEPC) has recently commenced work on the development of non-mandatory technical guidelines to minimise the introduction of incidental noise from commercial shipping operations into the marine environment. The MEPC has established an intersessional correspondence group, with the aim of identifying and addressing ways to minimise the introduction of incidental noise into the marine environment from commercial shipping to reduce the potential adverse impact on marine life and, in particular, to develop voluntary technical guidelines for ship-quieting technologies as well as potential navigation and operational practices. Resolution 9.19 invites both the CMS Secretariat and the parties to contribute to these endeavours.

In addition, the IMO's Guidelines for the Identification and Designation of Particularly Sensitive Sea Area (PSSA), i.e., ecologically sensitive areas which need special protection through action by IMO because of their vulnerability to international shipping, recognise noise from ships as a threat which may adversely affect the marine environment and marine living resources of the sea (Para 2.2). Within the ASCOBANS Area, the Baltic Sea, Wadden Sea and the Western part of the North Sea and the Channel have been so designated. Under Regulation A.982(24) of 1 December 2005, which establishes the PSSA Guidelines, the IMO may adopt "measures aimed at protecting specific sea areas against environmental damage from ships, provided that they have an identified legal basis" (Paragraph 6.1.3), which may include ship noise mitigation measures eventually developed by the IMO.

3.2.6 Regional Sea Conventions

Two Regional Sea Conventions are applicable within the ASCOBANS Area, namely HELCOM and OSPAR. In 1996 HELCOM adopted Recommendation 17/2 on the Protection of Harbour Porpoise in the Baltic Sea Area, identifying "disturbance" as a factor that may adversely affect this species. This measure recommended that the parties should take action in cooperation with ICES to collect and analyse data on threats to these animals, including "disturbance by shipping (e.g. underwater noise)". OSPAR, while not having to date adopted a specific provision addressing cetaceans, has nonetheless noted the potential problems of ocean noise within its Guidance on Environmental Considerations for Offshore Windfarm Development (2008-3), while "noise disturbance" is listed as an example of an effect of human activities within the Guidelines for the Management of Marine Protected Areas in the OSPAR Maritime Area (2003-18). OSPAR is currently considering a Draft assessment of the environmental impact of underwater noise in its programme of work.

4. Current Practice in Europe

Recommendations and guidelines addressing man-made underwater noise are available for seismic sources and / or for military activities by some countries in European waters[3].

The UK's Joint Nature Conservation Committee (JNCC) was the first agency in Europe to develop seismic guidance and this guidance has subsequently been adopted in some other countries around the world.

4.1 Joint Nature Conservation Committee (JNCC) Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveys

The JNCC guidelines were first put in place in 1995 when the scientific knowledge about the extent of adverse impacts of noise on marine mammals was limited. They have been updated periodically since then, most recently in June 2009. These were the first national guidelines to be developed and have subsequently become the standard, or basis, of international mitigation measures for noise pollution during seismic surveys. However, relatively few aspects of these measures have a firm scientific basis or proven efficacy[4]. The JNCC guidelines contain no obligation for continuous observations during the survey and no shut-downs to protect individual animals from harm once surveys are underway. Other factors not adequately considered in the JNCC guidance include compliance and enforcement; accounting for the number of airguns in use; environmental factors, such as inclement weather conditions; and oceanographic conditions, including variations in acoustic propagation. More generally there are no obligations to fill data gaps on species distributions and trends despite these gaps being considerable.

Almost every mitigation measure established in the JNCC guidelines results in a very small level of risk reduction. JNCC guidance offers an anthropocentric 'common sense' approach to species protection from intense noise sources and these guidelines have been influential on ASCOBANS practice in the past. However, in light of recent research and detailed study of observable impacts, these do not appear to be consistent with the actual or likely behaviour of marine mammals. Consequently, it is argued by Parsons *et al*. (2009)[5] that these guidelines do not meet the required legislative standards and are not adequately precautionary. The effectiveness of suggested mitigation techniques has to be critically investigated and qualified before seismic surveys will be approved.

4.2 The ACCOBAMS Guidelines to address the issue of the impact of anthropogenic noise on marine mammals

A more appropriate and holistic approach to manage human-induced underwater noise are the *Guidelines to address the issue of the impact of anthropogenic noise on marine mammals in the ACCOBAMS area*. These guidelines are based on agreements between the parties to this agreement (i.e ACCOBAMS Recommendation 2.7 and ACCOBAMS Resolution 2.16), the recommendations of the 56th and 58th meetings of the International

[3] For reviews see: Dolman S.J., Weir C.R. and Jasny M. (2009). Comparative review of marine mammal guidance implemented during naval exercises. Marine Pollution Bulletin, 58: 465-477.and Weir, C.R. and Dolman, S.J. 2007. Comparative review of the regional marine mammals mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard. J. Int.

Wildl. Law Pol. 10: 1-27.)..

[4] Parsons EC, Dolman SJ, Jasny M, Rose NA, Simmonds MP, Wright AJ. (2009) A critique of the UK's JNCC seismic survey guidelines for minimising acoustic disturbance to marine mammals: best practise? Mar Pollut Bull. May;58(5):643-51

[5] See footnote 4.

Whaling Commission (held in 2004 and in 2006), and on the European Parliament Motion B6-0089/04.

The ACCOBAMS *Guidelines* consider both the following human activities and the obligation to provide important information.

A – Sonar operations and sonar testing	Military operations (e.g. patrolling, training exercises) Civil operations (e.g. academic, research, testing)
B – Geophysical surveys and experiments	Seismic surveys (academic) Seismic surveys (oil/gas exploration) Acoustic experiments (e.g. ATOC or similar)
C – Coastal and offshore construction works and activities	Coastal and offshore construction & demolition works (e.g. ports, bridges, offshore platforms, etc.) Use of explosives for decommissioning structures Use of explosives for testing ships/submarines
D – Resources exploitation	Gas/oil/minerals extraction platforms and subsea processing. Drilling platforms Offshore renewables Extraction of sand and gravel
E – Scientific research on marine mammals	Playback experiments Controlled Exposure Experiments (CEE) Testing whale finding sonars
F – Other activities	Pingers and Acoustic Harassment Devices (AHD) to protect fisheries and water intakes Whale watching (touristic and scientific) Offshore races Blasting of residual war weapons Shipping

The ACCOBAMS *Guidelines* suggest that the following information should be provided before the noise emission takes place:

- A detailed description of the specific activity or class of activities that can be expected to result in disturbance or damage to marine mammals:
  - Date, duration, geographical region and sub-areas where it will occur;
  - Platform(s) to be used;
  - Acoustic source(s) features (source level, type of sound or time-frequency structure, directionality or spatial emission pattern (3D field), signal duration, and duty cycle or repetition rate);
  - Time plan of the acoustic emissions in the area or in each sub-area;
  - Physical and oceanographic features of the area(s);
  - Bathymetry, seafloor features and sound propagation models for the whole area(s); and
  - Noise levels and main noise sources already existing in the area(s).

- In case of scientific research on marine mammals additional data is required concerning:
  - Research protocol;
  - Expected exposure on individual targets;
  - Expected exposure on non-target individuals;
  - Expected exposure on other species; and
  - Expected benefits of the research.

- Environmental Impact Assessment
  - The species and numbers of marine mammals likely to be found within the activity area(s);
  - A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities;
  - Exposure model for the expected species and the type and range of incidental impacts that are being expected, considering the worst cases (i.e., harassment only, injury and/or death) that may occur in case of unexpected conditions, and also considering the cumulative and synergistic effects of the proposed action together with past, present, and reasonably foreseeable future activities affecting the same populations or species;
  - Presence of critical species, i.e. presence of endangered species or of species of known sensitivity to sound (e.g. beaked whales);
  - Presence of critical habitats, i.e. presence of habitats of key importance for marine mammal species or of habitats typical of critical species;
  - The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat, taking into account cumulative and synergistic effects of the proposed action together with past, present, and reasonably foreseeable future activities affecting the same habitat; and
  - The anticipated impact on the ecosystem and on prey species.

- The availability and feasibility (economic and technological) of conducting the activity elsewhere, of alternative, lower impact equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, or their habitat

- Mitigation procedures to be adopted:
  - Rules (relating to mitigation mechanisms, including inter alia exposure criteria, monitoring protocol, mitigation protocol, reporting protocol);
  - Personnel (team of marine mammal observers (MMO and BA), which should include visual and acoustic observers);
  - Equipment (specific equipment for visual observers and for passive acoustic monitoring);
  - Expected effectiveness of monitoring in different weather and light conditions;
  - Expected effectiveness of mitigation; and
  - Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

- Suggested means of learning, encouraging, and coordinating research opportunities, plans, and activities related to reducing such incidental impacts and evaluating their long term effects.

4.3 Statutory nature conservation agency protocol for minimising the risk of disturbance and injury to marine mammals from piling noise June 2009

During the compilation of this document, the JNCC, in combination with other UK agencies, issued further guidelines, this time concerning piling noise. We are not able to fully consider

these guidelines, which were only brought to our attention very recently, here but we do note that there is evidence that 'bubble curtains' can help to reduce noise transmission. Such evidence was provided to the Symposium of the German Federal Maritime and Hydrographic Agency in June 2009, in Hamburg, and can also be found on the 'Offshore-wind' website [6].

5. Effective Mitigation Guidance for intense noise generating activities in the ASCOBANS region

5.1 General Guidelines.

We believe that the current real-time mitigation efforts, whilst better than none at all, are largely either untested or known to be of extremely limited effectiveness. The following part of the document is mainly adapted from sections 5.7 and 5.8 of the ACCOBAMS anthropogenic noise guidelines prepared by Gianni Pavan[7].

Recommendation 1: Similar guidance to that provided in the ACCOBAMS guidelines should be used in the ASCOBANS area.

Recommendation 2: A description of monitoring and mitigation procedures should be included in the permit request; including definition of appropriate equipment and, where appropriate alternative technologies.

Recommendation 3: Monitoring and mitigation measures should be developed on a case by case basis so that they suit local conditions.

Recommendation 4: Mitigation measures should be more precautionary/restrictive for activities for which scientific information is limited or for situations where uncertainties are high.

Recommendation 5: In cases where the applicant is already required to adopt a mitigation policy[8], the more restrictive rules should apply.

We note that mitigation guidelines fall into three main categories which are further considered below:

1) Planning
2) Real-time Mitigation
3) Post-mitigation Monitoring and Reporting

5.2 Planning Stages

We believe that consideration of effective mitigation at the planning stage is essential. Of the various potential measures that might be applied, a properly implemented system of spatio-temporal avoidance, as part of a full and transparent Environmental Impact Assessment is, at present, the most effective way to reduce the impacts of intense noise pollution on marine species[9].

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[6] http://www.offshore-wind.de/page/index.php?id=11638&L=1

[7] Pavan G., 2007. Guidelines to address the issue of the impact of anthropogenic noise on marine mammals in the ACCOBAMS area. Report prepared for the 4th ACCOBAMS Scientific Committee. ACCOBAMS SC4 Doc 18

[8] For example US companies are under certain obligations to the US MMPA

[9] Agardy, T., Aguilar, N., Cañadas, A., Engel, M., Frantzis, A., Hatch, L., Hoyt, E., Kaschner, K., LaBrecque, E., Martin, V., Notarbartolo di Sciara, G., Pavan, G., Servidio, A., Smith, B., Wang, J., Weilgart, L., Wintle, B. and Wright, A. 2007. A Global Scientific Workshop on Spatio-Temporal Management of Noise. Report of the Scientific Workshop; Dolman S., Green M and Simmonds M. P. (2007) Marine Renewable Energy and Cetaceans. Paper presented to the Scientific Committee of the

Recommendation 6. Utilisation of spatio-temporal avoidance[10], as part of a full and transparent Environmental Impact Assessment.

Spatio-temporal avoidance may include:

- Year-round restrictions to avoid adversely affecting MPAs (including adequate surrounding buffer zones) or key marine mammals habitats;
- Seasonal restrictions to avoid adversely affecting MPAs or key marine mammals habitats during sensitive/critical periods of the life cycle (breeding, feeding, nursing, etc.); and
- Site selection to identify 'low-risk' areas where noise activities can be performed without affecting marine mammals.

Collection of field data to establish habitat use, abundance and distribution and suitable modelling to enable estimation of current densities should be a key component of the planning stage. These data should be considered in combination with the effects of oceanographic conditions on sound propagation, to make informed estimates of the comparative numbers of impacts associated with each potential location and mode of operation. Collection of additional field survey data in real-time will enable model verification and adaptive management.

Recommendation 7: Protocols and procedures should be standardised and the equipment necessary for monitoring defined in the permit request. (The permit could eventually also include additional monitoring and reporting requests.)

5.3 Real-time mitigation

Standards are required that define an appropriate level of cetacean monitoring, depending on the species likely to be affected and the activity to be undertaken. To improve the effectiveness of real-time mitigation, such measures must reflect the challenges involved in detecting some species that are particularly difficult to observe in the ASCOBANS region, including harbour porpoises.

Recommendation 8: Consideration should be given to both Source-based Mitigation and Operational-Mitigation.

Effective real-time measures include:

- Source-based mitigation
  - Technical and procedural modifications to reduce emitted level or other damaging noise characteristics such as rise time, wide beam pattern, long durations and duty cycles, etc.;
  - In the case of active sources (i.e. sonars and airguns), the use of only the minimum power required to achieve the expected results;
  - Activity reduction; and
  - Sound containment.
- Operational mitigation
  - Identification of exclusion zones or EZs[11] (which should be adaptive according to visibility, propagation models, oceanographic conditions);

IWC. SC/59/E10. Parsons, E.C.M., Dolman, S.J. Jasny, M., Rose, N.A., Simmonds, M.P. and Wright, A.J. 2009 A critique of the UK's JNCC seismic survey guidelines for minimising acoustic disturbance to marine mammals: Best practise? Marine Pollution Bulletin 58: 643-651

- Protocols requiring the shutting down of equipment under certain conditions or combination or conditions (e.g. presence of animals; poor visibility etc.);
- Restrictions to certain times of day or to duration of emissions;
- Dynamic modification of emitted power (e.g. power down rather than power off);
- Spatial and operational modification (e.g. to avoid high density areas or to provide escape routes and avoid embayment of marine mammals);
- Carefully specified and comprehensive monitoring;and reporting requirements; and
- Other contingency operational requirements – e.g. in case unexpected condition occurs.

Recommendation 9: the following should be implemented in terms of spatio-temporal and operational mitigation:

1. Consult databases detailing marine mammal spatial and seasonal distributions and habitats, so that activities can be planned and conducted either when and where animals are less likely to be encountered or in non-critical habitats:
2. Avoid marine mammals' key habitats and marine protected areas, define appropriate buffer zones around them;
3. Consider the possible impact of long-range propagation;
4. If data are not available, organize surveys (shipboard and/or aerial) to assess the population density in the areas chosen for operation, or setup alternative monitoring systems (e.g. passive acoustic monitoring with recoverable bottom recorders or radio-linked sonar-buoys);
5. Consider cumulative impacts over time and 'effects modeling'; include consideration of seasonal and historical impacts from other activities (shipping, military, industrial, other seismic) in the specific survey area and nearby region. For these purposes, databases/GIS that track the history of sonar/seismic and other industrial activities should be developed;
6. Model the generated sound field in relationship to oceanographic features (depth/temperature profile, sound channels, water depth, seafloor characteristics) and include consideration of existing background noise;
7. Safe and harmful exposure levels must be determined for any taxonomic group of concern (e.g. mysticetes, odontocetes, pinnipeds, marine turtles, fishes) or especially vulnerable species (e.g. beaked whales);
8. There should be a scientific and precautionary basis for any EZ, and rather than an arbitrary and/or static designation, the EZ should be dynamically modelled based on the characteristic of the source (power and directionality), on the expected species, and on the local propagation features (cylindrical vs spherical spreading, depth and type of sea bottom, local propagation paths related with thermal stratification);
9. Full and transparent environmental assessments should be developed that should aim to identify areas to be avoided (e.g. marine protected areas, feeding or breeding grounds or migration routes) and/or environmentally preferred exercise or seismic survey sites. Exercises or surveys should be planned so as to avoid key marine mammal habitats and areas of high marine mammal density, so that:
    a) entire habitats or migration paths are not blocked;

[11] Exclusion zone here means an area from which cetaceans and potentially other wildlife or fisheries should be excluded or absent – i.e. a zone around the noise source(s) which might also be described as a safety zone within which there is a potential for harm.

b) cumulative sonar sound and/or seismic noise is not focused within any particular area; and

c) multiple vessels operating acoustic devices in the same or nearby areas at the same time are prohibited; and

10. Assessments should be done within a transparent process that affords opportunity for public participation, as, for example, through an Environmental Impact Assessment or Strategic Impact Assessment framework.

Recommendation 10: Mitigation procedures should be practical in that they should use data that can be readily collected by marine mammal observers (MMOs) (of whom an appropriate number should be deployed), account for operating conditions and constraints, and, as far as possible, minimise disruption of operations while maximising environmental protection and meeting legislative requirements. Accurate reporting is required to verify the EIA hypotheses and the effectiveness of mitigation

Recommendation 11: the following should be implemented as part of Real-time Mitigation:

1. Adapt the coincidence of sonar and/or seismic lines to account for any predictable movements of animals across the survey area and avoid blocking escape routes;
2. In case of multiple EZ choices, the safest, most precautionary option should be adopted;
3. Consider establishment of an expanded EZ aimed at reducing behavioral disruption. (This should be based on received levels much lower than those supposed to produce physiological and physical damage. Whenever possible, consider an expanded EZ where exposure could be limited by reducing the emitted power (power-down) whilst maintaining acceptable operative capabilities.);
4. Marine mammal mitigation guidelines should be adopted and publicized by all operators, whether military, industrial or academic;
5. A system of automated logging of acoustic source use should be developed to document the amount of acoustic energy produced, and this information should be available to noise regulators and to the public;
6. Mitigation should include monitoring and reporting protocols to provide information on the implemented procedures, on their effectiveness, and to provide datasets to be used for improving existing marine mammal databases;
7. During operations, existing stranding networks in the area should be alerted; and, if required, additional monitoring of the closest coasts for deaths at sea should be organized;
8. If required, post-cruise surveys should be organised to verify if changes in the population densities or distributions, and also potentially any anomalous deaths, have occurred as a possible consequence of operations;
9. In any strandings possibly related to the operations are reported, any acoustic emission should be stopped and maximum effort devoted to understanding the causes of the deaths;
10. In the case of abnormal behaviours observed in animals inside or outside any EZ, any acoustic emission should be stopped and maximum effort addressed at monitoring those animals;
11. Continuous visual and passive acoustic monitoring (PAM) should be used to ensure that marine mammals are not in the EZ before turning on the acoustic sources and whilst sources are active;
12. Further to Recommendation 10 above, dedicated, appropriately trained and qualified Marine Mammal Observers (visual and acoustic where appropriate) should be

employed for the monitoring and reporting program including overseeing implemented mitigation rules;

13. Marine mammal observers and bio-acousticians in charge of the monitoring program must have suitable equipment;
14. Equipment for visual monitoring should include suitable binoculars, including big eyes, to be used according to the monitoring protocol;
15. High power sources and high power airgun configurations should be restricted at night, during other periods of low visibility, and during significant surface-ducting conditions, since current mitigation techniques may be inadequate to detect and localize marine mammals;
16. Because of the impact of adverse weather conditions on the visual detection of mammals, emission during unfavourable conditions should be restricted;
17. Passive acoustic monitoring (PAM)[12] should be used to improve detection capabilities. and should be mandatory for night operations or when visibility is poor;
18. Marine mammal observers should report directly to the regulating Agency by using a standardised reporting protocol; any unexpected condition and/or change in applied protocols should be discussed with the Agency (MMOs should not report directly to the companies conducting exploration);
19. At least two dedicated Marine Mammal Observers should be on watch at every time on every operative ship; organize shifts to allow enough rotation and resting periods to MMOs. In case of acoustic monitoring, at least one operator should be on watch and shifts should be organized to allow 24/24h operation, unless automatic detection/alerting systems with proven effectiveness are available;
20. Before beginning any emission there should be a dedicated watch of at least 30 minutes to ensure no animals are within the EZ;
21. Extra mitigation measures should be applied in deep water areas in beaked whale habitat and we note here the ECS Resolution on Active Sonar & Beaked Whales. If beaked whales have been seen diving on the vessel trackline or if habitats suitable for beaked whales are approached, the watch should be prolonged to 120 minutes to increase the probability that deep-diving species are detected (e.g. Cuvier's beaked whales). Ideally, however, sonar exercises should not be conducted in areas that beaked whales are known to inhabit;
22. Every time sources are turned on, there should be a slow increase of acoustic power (ramp-up or soft start) to allow marine mammals sufficient opportunity to leave the ensonified area in the event that visual and passive searches are unsuccessful (the effectiveness of this procedure is still undetermined);
23. The beginning of emissions should be delayed if marine mammal species are observed within the EZ or approaching it. Ramp-up may not begin until 30 minutes after the animals are seen to leave the EZ or 30 minutes after they are last seen (120 minutes in case of beaked whales);
24. There should be avoidance of exposure of animals to harmful acoustic levels by changing the ship's course, if applicable, or by reducing (power-down) or ceasing (shut-down) the acoustic emissions;
25. Shut-down of source(s) should occur whenever a marine mammal is seen to enter the EZ and whenever aggregations of vulnerable species (such as beaked whales) are detected anywhere within the monitoring area; and

[12] PAM should be conducted using towed array technology for moving ships, radio-transmitting sonorbuoys for stationary operations, or other suitable technologies with enough bandwidth to be sensitive to the whole frequency range of marine mammals expected in the area

26. Shut-down and consultation with relevant government agencies and experts should occur if an unusual stranding event occur during an exercise or survey.

5.4 Post Activity Monitoring & Reporting

Monitoring and reporting are two key activities for the implementation of mitigation procedures and for evaluating their effectiveness.

Accurate and unbiased data are required to document any possible effect on the local fauna and to assess the effectiveness of the adopted mitigation rules. In case this cannot be done adequately by observers undertaking mitigation, the responsible Agency should be able to setup an independent monitoring program. A monitoring program to investigate such effects could look for changes (or lack of changes) in behaviour, spatial distribution, abundance, and reproductive success. Baseline and control data are very helpful in understanding changes that may, or may not, occur during seismic/sonar surveys or during times when mitigation actions are in place. Control data include a wide variety of types of data, potentially including those obtained in a control area (i.e. an area similar to the area being used in the surveys but not affected by the noise or data collected before and after the noise exposure).

Recommendation 12: Visual observations and acoustic monitoring data must be accurately collected during activities carried out under a permit.

To document changes in animal behaviour and distribution, the program may have to look at a variety of scales (small and large temporal and spatial scales) and consider changes that may be temporary or permanent. Another aspect of such a monitoring program would be to collect data necessary to distinguish between changes due to a seismic/sonar survey (or mitigation measure) and changes due to natural factors (such as environmental shifts) or due to other human-related factors (such as fishery interactions).

Examples of methods to monitor small spatial temporal scale changes include using focal follows, monitoring swim directions of the cetaceans and detailed telemetry (e.g. using suction cup devices such as D-tags). Examples of methods to monitor medium spatial temporal scale changes include using satellite telemetry, or determining spatial distributions or relative abundances. A method used to monitor large spatial and long temporal scale changes for some baleen whales is to use autonomous seafloor-mounted instruments to monitor selected areas.

Recommendation 13: Post-Activity Monitoring & Reporting should be conducted in the following way:

1. All whale observational data should be made available in the public domain;
2. Monitoring data should be integrated with specific studies designed to investigate changes in distributions of whales with respect to seismic/sonar operations;
3. Monitoring data should be integrated with oceanographic data and with an automatic logging of ship tracks and acoustic source use; and
4. If required, independent monitoring stations could be used to monitor noise levels at different ranges from the source.

6. Guidelines for specific sources.

The following sources of acoustic disturbance are considered here:

- *Military sonars and civil high-power sonars*
- *Seismic surveys and airgun use*
- *Coastal and offshore construction works*

- *Offshore platforms*
- *Playback & Sound Exposure Experiments*
- *Other activities requiring mitigation guidance*

In the case of each source, the guidelines identified in Section 5 above should be applied and in this section we provide additional comment and describe additional source-specific recommendations.

6.1 Military sonars and civil high-power sonars

Planning

This should include:

a. The periodic collection of field survey data on the habitat use, abundance, and distribution of marine mammals in exercise areas, as well as on other biological and oceanographic variables;

b. The use of these data in a modelling context to make predictions of current marine mammal densities; and, in tandem with models of acoustic exposure (bearing in mind the effects of certain oceanographic conditions on sound propagation) the development of informed estimates of the comparative numbers of impacts associated with each potential location and mode of operation;

c. The collection of additional field survey data and confirmation of conditions for sound propagation closer to the time of operations, for purposes of model verification and adaptive management;

d. Until such time as reliable, extensive surveys and models are available for a given region, avoidance by Navies of important oceanographic features, such as canyons, steep walls, and seamounts, persistent upwellings, and bays, as well as Marine Protected Areas, such as those created under Natura 2000 and the SPAMI protocol, and known habitat and other high-density areas;

e. Implementation and further development by navies of passive acoustic monitoring (PAM), as an effective tool for identifying high-density areas in exercise planning and for real time monitoring of exercise areas; and,

f. During joint exercises between two navies, application of more stringent mitigation measures, even if these are not those of the host nation.

Real-time Mitigation

See section 5. General Guidelines

Post-exercise Monitoring & Reporting

a. Post-exercise monitoring should include cetacean surveys in the exercise area;

b. Transparent reporting to national authorities should occur within a predetermined timeframe, so that effectiveness and compliance to guidance can be monitored and appropriate adaptive management can be applied. Information provided should include visual conditions, number of observers and type of binoculars or other visual aids used for visual monitoring; for acoustic monitoring, navies should report background noise levels, number/spacing of hydrophones and types of detectors for classifying cetacean vocalisations. The probability of detection at different ranges and the probability of false alarms should be considered and reported both for visual and acoustic monitoring; and

c. Procedures for collecting observational data should be based on a standardised protocol

6.2. Seismic surveys and airgun use

Guidelines for mitigating the effects of seismic surveys are in place in a number of countries for the exploration of oil and gas deposits (for a full review, see Weir and Dolman, 2007[13]) and in the context of academic seismic surveys, mainly conducted under NMFS permits. Most of the following guidelines are equivalent to those required for sonar operations and should apply in addition to general guidelines:

Planning

See Section 5 and in addition:

Real-time Mitigation:

a) Limit horizontal propagation by adopting suitable array configurations and pulse synchronization and eliminating unnecessary high frequencies;

b) Modelling of the generated sound field in relation with oceanographic features (depth/temperature profile, water depth, seafloor characteristics) to dynamically set the EZ;

c) Mitigation procedures should be practical in that they should use data that can be readily collected by marine mammal observers during offshore operations, account for operating conditions and constraints of sonar surveys and, as far as possible, minimize disruption of surveys while maximizing environmental protection;

d) High power airgun configurations should be prohibited at night, during other periods of low visibility, and during significant surface-ducting conditions, since current mitigation techniques may be inadequate to detect and localize marine mammals. Because of the impact of adverse weather conditions on the visual detection of mammals, emission during unfavourable conditions should be restricted;

e) Ensure that seismic survey vessels operating in the same area maintain a minimum separation distance to allow escape routes between sound fields;

f) Shut down and consultation with relevant government agencies and experts should an unusual stranding event occur during a survey; and,

g) Strive for data-sharing among surveyors to minimise duplicate surveying**.**

6.3. Coastal and offshore works, including harbour construction & dredging; oil & gas platforms; and marine renewable energy developments

Offshore platforms may be used for a variety of different activities, such as seafloor drilling, oil/gas extraction, electricity production (e.g. wind-farms) and each one will have its own particular impacts on the marine environment. Their placement should be carefully regulated; and if their impacts include those related to noise, they should require a specific permit with monitoring and mitigation rules to be defined on a case-by-case basis and separately for the construction phase and for the operative life.

The growing number of wind-farms in coastal areas[14] may have an impact on cetaceans, in particular because of the construction and operational noise associated with them[15]. They should be designed and operated to produce the lowest possible noise in both phases.

[13] Full reference in footnote 3

[14] For a recent review of the extent of windfarm and other marine renewable developments in northern Europe see: Brown, V.C. and Simmonds, M.P. 2009. A further update on the distributions of marine renewable energy plants in Europe. IWC/SC/61/E7 paper submitted to the Scientific Committee of the IWC. 20 pages.

Coastal and offshore construction works, which may include demolition of existent structures, may produce high noise levels, even for prolonged periods, depending on the technologies used and on local propagation features that include propagation through the substrate.

Construction works on the coast or on the shoreline, including harbours and marine renewable energy developments, may propagate noise (e.g. from pile drivers and jack hammers) over wide areas in particular where the substrate is rocky[16]. Traditional percussive pile-driving produce vibrations that propagate well and can ensonify wide marine areas with ranges to more than 100km[17]; in such conditions alternative technologies should be used. In some cases mitigation can be achieved through the use of bubble curtains[18] or material screens that attenuate sound emitted from the source or other technical modification.

In case of prolonged activities, such as construction works of large structures, a scheduling of the most noisy activities could be evaluated as a measure to avoid continuous exposures especially during critical periods for marine mammals living or transiting in the area; concentration of noisy operations in short periods of time and alternative construction technologies should also be evaluated to minimize noise impact.

The construction of marine wind-farms (in particular the pile driving process) has much greater potential for causing acute effects such as physical damage and hearing loss than the operation of the facility once built. The broadband pulsive noise generated during pile driving has a high source level.[19] Pile driving is dominated by low frequency sounds but also contains some higher frequencies including infrasonics.[20]

Given such intense sound production, it is perhaps not surprising that porpoise densities at the Nysted and Horns Rev offshore wind farms in Denmark decreased over considerable ranges during pile driving for wind farm construction.[21] Such effects may well lead to significant impacts. Please also see comments in section 4.2.

Consideration of injury as well as disturbance and habitat avoidance is appropriate. Cetaceans have highly-developed acoustic sensory systems, which enable them to communicate, navigate, orientate, forage and to avoid predators in the marine environment, where sound is a much more important sense than vision. Sound propagation conditions in inshore waters are often between 15 and 20 Log(r) meaning that animals within ranges of several hundreds to thousands of metres of piling are at risk of Temporary Threshold Shift (TTS)[22] Lucke et al. (2007)[23] provided the first direct evidence of effects on the hearing of the

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[15] Madsen, P. T., Wahlberg, M., Tougaard, J., Lucke, K. and Tyack P. 2006. Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. *Marine Ecology Progress Series*, 309: 279-295.

[16] Tyack P. 2003.Research Program to Evaluate Effects of Manmade Noise on Marine Mammals in the Ligurian Sea. ACCOBAMS Document CS2/Inf. 13 and Pavan, personal observation

[17] David, 2006; Madsen, P.T., Johnson, M., Miller, P.J.O., Soto, N.A., Lynch, J. and Tyack, P. 2006. Quantitative measures of air-gun pulses recorded on sperm whales (Physeter macrocephalus) using acoustic tags during controlled exposure experiments. J. Acoust. Soc. 120: 2366-2379 and Pavan, personal observation

[18] Wursig B., Greene C.R., Jefferson T.A., 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. Marine Environmental Research 49: 79-93.

[19] SMRU, 2007. Workshop on technology requirements to investigate the effects of sound on marine wildlife. Sponsored by the International Association of Oil and Gas Producers Joint Industry Programme on Sound and Marine Life, St Andrews, 20-22 March 2007**,** 53 pages.

[20] Parvin, S. & Nedwell, J.R. (2006). Underwater noise survey during impact piling to construct the Barrow Offshore Wind Farm. Subacoustech Report No. 544R0602, 10th April 2006.

[21] Carstensen, J. Henriksen, O.D. & Teilmann, J. 2006. Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). *Marine Ecology Progress Series,* 321: 295- 308 and Tougaard, J., Carstensen, J., Henriksen, O.D., Skov, H. and Teilmann, J. 2003. Short-term effects of the construction of wind turbines on harbour porpoises at Horns Reef. Technical Report to Techwise A/S. Hedeselskabet.

[22] As reference 19.

harbour porpoise and the first evidence of impacts of low frequency impulsive sounds with similar characteristics to those from pile driving on the hearing sensitivity of any cetacean. This work indicates that, even though the hearing sensitivity of harbour porpoise is low at the frequencies at which most of the airgun sound energy occurs, TTS is induced at higher frequencies. TTS is induced at very much lower received energy levels in harbour porpoise than in the other cetacean species investigated so far[24]. Recovery of the harbour porpoises took more than 24 hours. This research has profound implications for the use of pile driving, given that porpoises are wide spread around the coastlines of countries that are Parties to ASCOBANS.

Reductions in emitted noise pollution show promise. For example, a pile driving sleeve is an option that has been investigated and could be brought into production in a short time frame The report concluded that deploying insulating sleeves around piles may be both a practical and economical method of effectively reducing noise levels. Other solutions to reducing noise could include alternative pile designs such as gravity bases or "jacket" approaches (these are structures based on offshore oil platforms which use smaller piles to attach to the seafloor), although in some cases, these approaches may not be technically or commercially viable.[25]

It is also important to consider the noise that will be generated by the structures once they are operative. Bridges propagate vibrations related with the traffic; offshore wind-farms and oil extraction platforms produce their own noise and thus their environmental impact should be carefully evaluated and mitigated with dedicated rules.

Planning:

a) Modelling of the generated sound field in relation with geological and oceanographic features (depth/temperature profile, water depth, coastal and seafloor characteristics) and existing noise levels (to be extensively monitored before any activity begins); define the area within which animals could receive harmful noise levels (i.e. the Exclusion Zone or EZ);

b) Schedule the noise producing activities according to the presence of marine mammals, if seasonal; and,

c) Use alternative technologies or adopt countermeasures to reduce noise diffusion, e.g. bubble curtains.

Real-time mitigation:

d) Setup noise monitoring stations at given distances from the source area to monitor for both local and long range noise levels and verify if predicted levels are reached or not;

e) Setup visual observation points/platforms to monitor for the presence and behaviour of marine mammals;

Post-Activity Monitoring & Reporting

See section 5 General Guidelines

[23] Lucke, K., Lepper, P.A., Blanchet, M-A., & Siebert, U. 2007 Testing the auditory tolerance of harbour porpoise hearing for impulsive sounds. poster. european cetacean society. Poster European Cetacean Society.

[24] As reference 19

[25] Prior, A. and McMath, M.J. 2008. Marine mammals and noise from offshore renewable energy projects – UK developments In: Evans, P.G.H. (ed.) 2008. *Proceedings of the ASCOBANS/ECS workshop*: offshore wind farms and marine mammals: impacts & methodologies for assessing impacts. San Sebastian, Spain, 21st April 2007. ECS special publication series no. 49 Feb 2008

6.4. Playback And Sound Exposure Experiments

Playback and Controlled Exposure Experiments (CEEs) are experiments in which animals in the wild are exposed to controlled doses of sound for the purposes of assessing their behaviour or physiological responses. CEEs now include a new category of studies called Behavioural Response Study (BRS).

These studies introduce additional sound into the ocean and may potentially expose not only the target species and/or individuals to be studied, but also additional ones. These considerations need to be balanced against the potential for these studies to provide answers to management questions on a case by case basis.

Given the controversial nature of these studies it is particularly important they are carefully designed and their limitations and risks acknowledged. In order to achieve optimal scientific and conservation value, those involved in conducting, funding and managing such experiments should strive for international cooperation, coordination and information exchange and, where possible joint programmes of work. Avoidance of duplicative or overlapping research will also help to prevent any unnecessary introduction of noise into the marine environment.

Controlled Exposure Experiments tend to use, as much as possible, sound exposures that are realistic and with the same characteristics of sound that the mammals are likely to be exposed to by ongoing sound operations. Behavioural Response Studies, on the contrary, are oriented at determining the minimum sound exposure level required to elicit a behavioural response.

In both cases, to be effective they must be preceded, as stated above, by baseline studies of behaviour and physiology that enable the results of the experiments to be interpreted as to their significance. To eliminate possible bias and arguments that will make the research valueless for regulatory purposes, there should be clear agreement, in advance, as to what constitutes a biologically significant effect.

As with all research, methods that can yield conclusive results with less risk of harm to the animals should be the preferred ones. Systematic observations using ongoing sound-producing activities should be used in place of CEEs if they can provide similar information. In some cases, it can be particularly difficult to conduct full programs of CEEs when large and expensive sound sources (such as airgun arrays or military sonar) are being investigated. Systematic studies of ongoing sound-producing activities can strengthen monitoring efforts required as mitigation, and have the benefit that such studies do not introduce additional sound directed at the mammals. The advantages of observational studies are increased as more attention is given to optimising measurement methods and study designs with the greatest power to detect real effects and provide convincing results. In practice, research investigating the impacts of large sound sources could be most successful when using a suite of approaches including observations of both controlled and uncontrolled sound exposures.

Sound exposure experiments require an accurate protocol to manage every possible interaction among the sound source(s) and the target(s).

Whilst designing and conducting such experiments, the following guidelines should be taken into consideration:

- Use sound exposures that are realistic and with the same characteristics of sound that the mammals are likely to be exposed to;
- Model sound propagation from the source to the targets based on local oceanographic features and background noise information;
- Use all available technologies to monitor both target and non-target animals; monitor other individuals and species – which may require different methods but may provide additional information;

- Consider that most monitored animals should be those exposed to highest levels;
- Halt sound emission if adverse response or behavioural changes are observed on either target or non target animals;
- Limit repeated exposures on the same target(s) unless required by the research protocol;
- Avoid enclosed areas, avoid blocking escape routes;
- Avoid "chasing" animals during playback; if they move away don't follow them with playback source;
- Exposures using animal sounds have been shown to elicit particularly strong responses, so avoid playing back sounds of predators and distorted versions of animals' own vocalisations unless specifically required by the research protocol; and
- Where predators sounds are used, limit exposures to the minimum required to get consistent results as repeated exposures could induce habituation

6.5 Other activities that require mitigation guidance

Any activity that produces noise above levels that may pose risks to marine mammals should require a permit.

6.5.1 Commercial whale & dolphin watching

Boat based dolphin and whale watching is an activity that is steadily increasing and that may have an impact on marine mammal populations, stocks, and individuals. Rules and permits are already in force in many countries, but the noise issue is seldom taken into consideration. Noise irradiated by engines and propellers is an important component of the disturbance to animals.[26] Beyond complying with national rules and restrictions, whale watching operators should also comply with noise emission restrictions.

6.5.2 Detonation of residual war weapons and use of explosives for testing or for decommissioning structures

In many ASCOBANS areas the detonation *in situ* of residual war weapons is a recurrent activity that requires special care. Explosives are also used widely for offshore decommissioning of structures and also for military trials, e.g. for testing ships and submarines. Both of these activities have the real possibility of injuring and killing animals within a certain distance of the source.

In all such cases both planning and real-time mitigation measures are required to minimise impacts. For example, the definition of an EZ is required, based on the power of the expected explosion(s) and on the local oceanographic features. The EZ should be monitored to be sure no animals are inside it and the watch before starting operations should be at least 30 min in duration and extended to 120 minutes in areas where deep diving species could be present.

Additional measures could include using alternative methods for safe collection of munitions and the use of bubble curtains[27] to attenuate the shock wave, or at least to dampen the shock wave onset. The use of aversive sound devices to remove animals from the danger

[26] See for example: Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. Mar. Mamm. Sci. 18: 394-418.

[27] Wursig B., Greene C.R., Jefferson T.A., 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. Marine Environmental Research 49: 79-93.

area for the relatively short period of blasting holds great promise for mitigation. However, further studies to develop and test such devices with the range of species of interest would be required before these could be relied on for mitigation.

6.5.3 Underwater acoustically-active devices

Underwater acoustics is an expanding field and new acoustic techniques are continuously being developed, tested and applied for a variety of uses; for example for searching, monitoring and/or exploiting environmental resources; for conducting scientific research, and for military purposes. Examples of activities that may require mitigation guidance include: oceanographic experiments based on the use of high power acoustic sources, including the use of acoustic positioning devices, the use of deterrent devices (Pingers and Acoustic Harassment Devices, in particular if used in array), e.g. to protect commercial fisheries or to protect industrial water intakes (e.g. cooling systems).

In all cases where high noise levels are expected in areas with the potential presence of marine mammals, at least the following guidelines should apply:

a) Modelling of the generated sound field in relation to local oceanographic features (depth/temperature profile, water depth, coastal and seafloor characteristics);

b) Definition of the area within which the animals might receive harmful noise levels (the Exclusion Zone or EZ);

c) Planning of activities for areas with low marine mammal densities, avoiding wherever possible sensitive species, such as beaked whales;

d) Scheduling of the noise-producing activities according to the presence/absence of marine mammals, if seasonal;

e) Setting up noise monitoring stations to monitor for both local and long range noise levels and verification if predicted levels are reached or not;

f) Setting up visual observation points/platforms to monitor for the presence and behaviour of marine mammals; and

g) In areas where water depths in the EZ exceed 200m the watch should be at least 120 minutes to increase the probability that deep-diving species are detected.